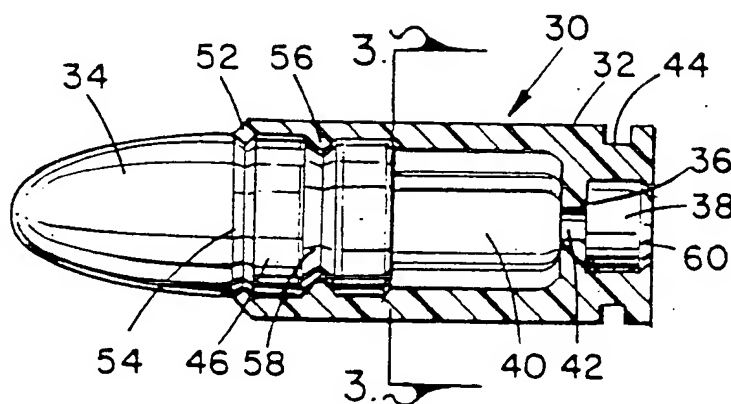




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(54) Title: AMMUNITION CASING AND BULLET



(57) Abstract

Improved shells for rifles and handguns employ casings (32, 66, 80) made of high strength, high temperature and flame resistant polymeric materials, preferably thermo-plastics, which are flexible, resilient and able to withstand much elongation. Means (52, 56, 60, 68, 70, 72, 96) for locating and retaining primers and bullets are integrally formed with the casing. An improved bullet has an inner metal pellet (114) lodged in a plastic cup (116).

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AMMUNITION CASING AND BULLET

5

Technical Field

This invention relates to improvements in bullet casings and bullets for firearms.

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Background Art

5 For many years the standard ammunition for
rifles and handguns has consisted of a shell consisting
of a case in tubular form. A bullet, commonly made of
lead, is inserted into one end of the tubular case,
and the other end of the case, which normally has a
10 smaller inside diameter, houses a percussion responsive
cap, or primer. The propellant is disposed within the
case between the primer and the bullet. In the usual
form, a dividing wall extends across the interior of the
casing just forward of the primer, and communication be-
15 tween the primer and the explosive powder is afforded
through an opening in that dividing wall. In rim fire
ammunition, no dividing wall is necessary.

 The case is ordinarily provided with confor-
20 mations, usually an annular recess around the circumfer-
ence of the casing toward its rear, which are employed
to facilitate ejection of spent shells and sometimes in
connection with loading of the shell into the firing cham-
ber. The requirement for simplicity in manufacture,
25 long shelf life, dimensional stability, and other fac-
tors, led to the almost universal adoption of brass as
the casing material. The configuration of the shell
casing is fairly complex. It is generally tubular. It
has a transverse dividing wall perforated with a circu-
30 lar central opening. The inner diameter at the rearward
side is less than the inner diameter at the forward
side of that transverse wall. Brass is sufficiently
malleable and stable and corrosion resistant to have be-
come the standard. However, brass casings are expensive,
35 both because the components of brass are a relatively
scarce resource and because the cost of processing brass
into the required shape is relatively expensive. They

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are sufficiently expensive so that it is customary to
retrieve spent shell casings and to recase them in manu-
5 facture of the ammunition.

There has long been need for a less expensive
and better shell casing material. It is the purpose
of this invention to provide one.

10

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Disclosure of Invention

5 It is an object of the invention to provide improved shells and, in particular, to provide improved shell casings, bullets, and bullet and casing combinations.

10 In the invention polymeric materials are substituted for the brass and, in some preferred embodiments, the bullet itself is partially formed of a polymeric material. The transistion from brass to polymeric material is not merely one of substitution. It is advantageous
15 to retain the basic casing structure so that plastic encased ammunition can be employed in existing firearms using existing loading and ejecting mechanisms and firing pins, and the like. It is equally advantageous, and the preferred embodiment does so, to retain the basic internal
20 structure of the brass casing to take advantage of the availability of existing primers and bullets. On the other hand, there is no mere substitution of physical characteristics. The brass shell is rigid and hard. Its side wall is very thin, and the whole is relatively
25 inelastic. Shell casings, according to the invention, are fabricated with polymeric materials that exhibit high degrees of elongation without failure, relatively high degrees of flexibility, and different shapes. The amount of the power load is controlled by controlling the
30 wall thickness to adjust the size of the powder cavity. The color of the casing material is varied to serve as a code to identify ammunition according to its characteristics.

35 Some of the important features of the invention lie in the inclusion of means by which the bullet is limited to an appropriate degree of insertion in the

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casing, by which the primer is retained in place, and by the inclusion of an improved means for retaining the bullet within the casing. In each case, the means by which the bullet and primer are located relative to the casing and retained in place is accomplished with a conformation integrally formed with the casing on its inner surface. The preferred means for retaining the primer employs an inwardly extending flange at the rim of the casing about the cavity in which the primer is disposed. In preferred form, that flange is segmented around its periphery to facilitate distortion of the flange to permit insertion of the primer. The primer having been inserted, the flange regains its shape and serves to retain the primer. A similar construction is employed at the forward rim of the casing for the purpose of retaining the bullet within the casing. Here, again, the flange extends inwardly at the rim of the casing and, in preferred form, is segmented to facilitate its distortion to permit insertion of the bullet.

Segmentation is not necessary, and, indeed, is not preferred in those circumstances in which the bullet locating conformation is accomplished by an annular ring formed on the inner surface of the casing along the length of the powder and shell cavity of the casing. When the ring is employed the bullet is provided with a complementary annular groove. Such a ring serves both as a locator and a retaining element. There is nothing to prevent the use of more than one set of conformations to accomplish location and retention. In appropriate cases, both the ring and the flange are employed. A retention system that is particularly useful in the case of bullets made of relatively soft material is provided by arranging the inner surface of the casing at the forward end of the powder and bullet cavity with a number of inwardly ex-

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tending projections. Those projections need be no more than pyrimidally shaped projections, or the like, or to have a form similar to screw threads, so that the bullet can be locked in place by twisting it after insertion.

It is not essential that a bullet be made entirely of metal. The invention provides a bullet at least the outer peripheral portion of which, and the rear portion of which, are formed of a polymeric material whose characteristics are similar to those of the casing itself. That is, they are required to have high strength, be flame resistant, and to withstand elongation in considerable degree. Such a bullet can be made entirely of plastic, although in most applications, it will be preferable to have a greater mass than is feasible to provide in an all plastic bullet. Thus, in the preferred form for most applications, the polymeric portions of the bullet will surround a metallic core that, in most cases, will extend forwardly of its plastic enclosure.

Another major advantage of the shell provided by the invention lies in the fact that the polymeric casing can be applied to ammunition of the form that has its casing necked down at the forward end. That configuration is common in ammunition for rifles where it is desired to employ a relatively large volume of explosive powder within the casing without unduly elongating the shell. Shells of that configuration are relatively common, and many existing firearms have ammunition chambers designed to accommodate such ammunition. The invention provides a shell for such ammunition which comprises several portions which are fabricated independently and then bonded together to form a completed casing.

The preferred casing material is a polymer, a

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thermoplastic rather than a thermsetting polymer,
which has a high strength and is heat and flame resistant.
5 Unlike brass, it is flexible in some degree and exhibits
resilience. Further, it is capable of a substantial
degree of elongation without failure. Elongations of
eighty percent or more are preferred. Suitable and
preferred materials are polysulfone, polyimide-amide and
10 polyethylene sulfone.

These and other objects and advantages of the
invention will become apparent upon reading of the spe-
cification that follows and an examination of the accom-
15 panying drawings. Several embodiments are illustrated
and described. Each is a preferred form of the inven-
tion for a given application. It is to be understood
that the embodiments shown have been selected in response
to the requirement for a description of preferred embodi-
20 ments. It is to be understood, however, that the inven-
tion is applicable to other embodiments and forms of
the invention than those selected for illustration.

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Brief Description of the Drawings

5 In the drawings:

Figure 1 is a cross-sectional view of a shell casing and bullet assembly illustrating past practice;

10

Figure 2 is a cross-sectional view of a bullet and shell casing of one preferred embodiment of the invention;

15

Figure 3 is a cross-sectional view taken on line 3-3 of Figure 2;

20

Figure 4 is a cross-sectional view of a fragment of the forward portion and forward rim of the shell casing illustrated in Figure 2;

25

Figure 5 is a cross-sectional view of a fragment of the primer end of the casing illustrated in Figure 2;

30

Figure 6 is a view in rear elevation of the primer and of the shell casing illustrated in Figures 2 and 5;

35

Figure 7 is an exploded view of the bullet and shell casing of another embodiment of the invention which is preferred in certain circumstances;

Figure 8 is a view, partly in elevation and partly in section, of a form of bullet that is alternative to the form illustrated in Figure 7;

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5 Figure 9 is a composite drawing of two rifle shells, one in the upper portion of the figure and the other in the lower portion of the figure, which illustrate alternative forms of the invention that are preferred in certain circumstances;

10 Figure 10 is a composite drawing in cross-section taken on line 10-10 of Figure 9; and

15 Figure 11 is a cross-sectional view of a rim fired cartridge having a plastic shell and a plastic covered, lead core bullet.

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Description of the Preferred Embodiment

5 A typical prior art handgun shell is shown
in Figure 1. The primer and the powder have been omit-
ted. Only the casing and the bullet are shown. The
assembly, which is generally designated 12, includes a
bullet 14 which is partially inserted into the forward
10 end of the tubular casing 16. A transverse wall 18 divides
the casing into two chambers. The bullet and powder cham-
ber 20 is at the forward end of the casing, and the primer
chamber 22 opens to the rear of the casing. There is a
through opening 24 at the center of that dividing wall
15 so that products of the explosion of the primer in the
primer chamber, communicated to the powder in the powder
and bullet chamber 20, ignite the powder. The primer
chamber has smaller inside diameter than does the powder
and bullet chamber. The wall of the latter is tapered
20 toward the forward edge of the casing to provide draft
for the removal of the tool with which the cavity is
formed, and to make that outer edge of the casing wall
less strong so that it can be distorted or upset slightly
to pinch the shank of the bullet sufficiently to retain
25 the bullet in place. The rearward portion 26 of the bul-
let, that portion that is disposed within the forward
end of the casing, is formed with a peripheral groove
midway along its length. That groove is relatively wide,
and makes it possible to pinch the bullet in place with a
30 minimum amount of case distortion. In large measure the
bullet is held in place by friction. It is pressed into
place and friction is relied on to keep it there. The
exterior of the case is cylindrical and must remain cylin-
drical so that the bullet may be removed from the firing
35 chamber with minimum force. To facilitate handling of
the case, particularly in ejection of the case after
firing of the shell, a groove is formed around the peri-

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phery of the shell near its rearward end. In this case, that groove is V-shaped in cross-section and is identified by the reference numeral 28. The assembly is symmetrical about its longitudinal axis so that there is no need to accomplish any rotational orientation about that axis in the insertion and firing of the shell.

The casing is formed of brass. The bullet is usually wholly or partially formed of lead. The bullet is not recoverable, but it is very common to attempt to retrieve the brass case. The case is the most expensive part of the loaded cartridge, and it is common practice to reload spent shells up to ten times or more. That is possible because the brass shell, being maleable, expands to the chamber dimension in the thin wall area holding bullet, but can be reformed to size for reloading purposes. The casing is made of hard brass. Its hoop strength is high. The bullet is forced from the case more easily when the casing is expanded from the pressure created by the burning powder.

A corresponding assembly of bullet and shell case is illustrated in Figure 2. The basic shape of the case has been retained. The invention can accommodate existing primers and existing shell and ejection mechanisms, so the preferred embodiment retains the basic shape found in the brass case of Figure 1. Thus, the assembly 30 of Figure 2 includes a case 32 and a bullet 34. As in the case of past casings, the case 32 is generally cylindrical. It is provided with a transverse interior dividing wall 36 which separates the rearward chamber 38 from the forward powder and bullet chamber 40. The wall 36 is provided with a central opening 42 to afford communication between the two chambers. Peripheral groove 44, near the rearward end of the case is

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square in cross-section as distinguished from the V-shaped groove 28 of Figure 1, but the form of that groove is determined by the mechanisms of the gun that will employ it. Shape of that groove is not material except that, in the invention, wider range of shapes is permissible because of the fabrication procedures.

10 The invention can accommodate a wide range of bullet shapes. The bullet selected for illustration in Figure 2 has a rearward end 46 which is similar in shape to the rearward portion of the bullet 14 of Figure 1. The manner in which that bullet is held in place and is positioned is substantially different in Figure 2 than it is in Figure 1. The casing 32 includes a means for limiting the degree of insertion of the bullet into the casing. In this embodiment that means comprises three elements. The primary means for limiting the degree of insertion is afforded by a plurality of ribs that extend longitudinally along the interior wall of the rearward portion of the powder and bullet chamber 40. They are, in fact, limited to that region of the chamber in which the powder is housed. In this embodiment there are six ribs. That is best shown in Figure 3. They are equally spaced around the inner periphery of the casing, and are formed integrally with the casing wall. For identification, two of those ribs have been numbered 48 and 50, respectively. The rearward end of the bullet is seated against the forward faces of those several ribs.

 The degree of insertion of the bullet is limited also by an inwardly projecting flange 52 which is formed on the forward rim of the case, and integrally with the case body. That flange extends into a complementally shaped groove 54 which is formed around the periphery of the bullet 34. The flange 52 fits into that

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groove and serves primarily to retain the bullet within the case, but secondarily, to limit the degree of insertion. In this embodiment, the case is formed with a second inwardly extending peripheral groove. It is numbered 56 and it is located approximately midway between the forward surface of the several ribs and the flange 52. The ring 56 is generally triangular in cross-section, and it extends and fits into the peripheral groove 58 that is formed in the surface of the bullet. The ring 56 serves also as a means for retaining the bullet in place, as well as a means for limiting the degree of insertion. It is not essential that redundant insertion limitation and retention means be provided, but they are provided in this preferred embodiment.

Provision of such means, and to provide them redundantly, can be accomplished because the case is made flexible. The degree of flexibility need not be very great. The material is not merely pliant; it is elastomeric. It is free to expand under the force of the explosion to fill the firing chamber in the region around the case, thus to preclude entry of the combustion products into the space between the case and the chamber wall. Having the quality of resilience, it is possible to provide inwardly extending rings and flanges whose inside diameter is less than the diameter of some of the parts past those rings and flanges as the bullet is inserted into the case. Moreover, fabrication is entirely possible using relatively inexpensive tooling because the ability of the casing material to stretch permits removal of the tool, notwithstanding inclusion of inwardly directed rings and flanges.

The case of shells made in accordance with the invention are made of polymeric material which can

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be bent and stretched and has elasticity and renitence to urge it to original form. The construction of the flange 52 and the ring 56 is shown on an enlarged scale in Figure 4. In this case, both the flange and the ring are continuous. In some instances, particularly when heavy powder loads are employed, it is preferred that the case material be less resilient. In that circumstance, the ring 56 is ordinarily omitted and the inwardly directed flange 52 is segmented around the periphery in that it is notched at spaced points around its periphery. The result is an inwardly directed set of teeth rather than a solid flange. That toothed flange construction is employed in the embodiment of Figure 2 at the rearward end of the case, as best shown in Figures 5 and 6. The diameter of the primer cavity is substantially less than the diameter of the powder and bullet cavity. Since the outside diameter of the casing is substantially uniform throughout its length, it follows that the casing wall is heavier about the primer cavity. To facilitate retention of the primer, without unduly complicating its insertion, the means for retaining the primer in position in the cavity is an inwardly directed flange which is segmented at spaced points throughout its circumference. The flange is generally designated 60 in Figures 2 and 5, and several of the individual teeth that form that flange are designated 60, in the case of one, and 62, in the case of another.

The bullet 64 and the case 66 are shown separated in Figure 7. In this case, the means for retaining the primer is a continuous annular flange formed about the rearward rim of the primer cavity. The flange is triangular in cross-section. The cross-sectional area is relatively small. A means for limiting the degree of insertion of the bullet 64 into the case 60 is an inwardly

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directed ring which is formed integrally with the inner wall of the case. It is identified by the reference numeral 70, and it is not unlike the ring 56 of Figure 2, except that in this case it is positioned in the place within the tubular casing at which the rearward end of the bullet is to fit. In this case, the outer periphery of the bullet is smooth, and the inner wall of the case forward of the ring 60 is irregular in that many projections of the wall material extend into the cavity in slight degree. Those projections may have any of a variety of forms. The preferred form is shown. Each of the projections is generally pyramidal in shape. For the purpose of identification, several of them have been identified with the reference numeral 72. This design, like that shown in Figure 2, may have any value in a relatively large range of hardnesses. Some resilience is required so that the retaining flange 68 will yield as the primer is forced into place. Some yielding of the projection 72 is helpful to facilitate insertion of the bullet. Following insertion, the bullet can be locked in place by twisting it slightly or, alternatively, by subjecting the case to what corresponds to a swaging operation except that the material of the case is not stretched beyond its elastic limit. An alternative showing in Figure 7 is intended to illustrate, along with the projections, a pseudo thread configuration into which the bullet can be effectively screwed by rotating it a few degrees relative to the case after the bullet has been inserted.

Cases made according to the invention are made of polymeric material. The preferred material is a thermoplastic. It has high strength, can withstand high temperatures and is flame resistant, is flexible and can undergo a very substantial degree of elongation.

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Elongation up to eighty or 100 percent is preferred. Suitable materials are manufactured by a number of plastic material suppliers. Polysulfone, polyethylene sulfone and polyimide-amide are materials that have the requisite properties, and these three are the materials that are currently preferred.

Some embodiments of the invention employ structural forms that can be molded only with difficulty primarily because the tooling would be difficult to remove from the interior of the shell. However, the preferred materials are thermo-plastics which can be welded together with a liquid solvent material or ultra-sonics. That makes it possible to fabricate the shell, or a bullet casing, by welding together several individual parts. Shell casings which illustrate that feature are shown in Figures 9 and 10. Each of those two figures illustrates two embodiments of the invention which have been arranged side by side to facilitate comparison. Thus, the upper half of Figure 9 shows one embodiment, whereas the lower half illustrates another. Both employ casings that are larger in diameter than is the bullet. That construction is common in ammunition for rifles where it is desired to increase the amount of powder for a given bullet size without undue elongation of the shell. At the upper half of Figure 9, the numeral 80 designates the case, and the numeral 82 identifies the bullet that is inserted into the forward end 84 of the case. The forward end 84 has an inside diameter which is substantially less than the inside diameter of the remainder of the forward cavity of the case. Molding the case in one piece would make it difficult to remove the molding tool from the interior of the cavity, but that difficulty is overcome by making the case in two sections. The rearward section 86 of the case is not unlike the rearward

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portions of the case 32 in Figure 2, and 66 in Figure 7. At its forward end, however, the rearward section 86 has reduced diameter. A shoulder is formed which mates with the rearward end 88 of the forward section 90. The portion 88 serves as a sleeve which fits in the reduced diameter portion 92 of the section 86. Sections 90 and 84 are integrally formed. They are joined by an intermediate section 94 where the element tapers down to smaller inside and outside diameter. A ring 96 is formed around the periphery of the inner side of the section 94. That ring fits within a complementally formed groove that is formed around the periphery of the bullet 82 near its rearward end. The bullet 100 at the lower side of Figure 9 is a little longer than bullet 82, and its forward end is differently shaped. At its rearward end, it has similar shape. A groove 102 receives an inner ring 104 that is formed on the inner surface of the forward section 106 of the shell which is generally designated 108. Section 106 corresponds to section 84 above. It has reduced diameter relative to the rearward portions of the case. The case 108 is like the case 80 with two exceptions. The thickness of the wall of the rearward section is much greater in the case of case 108, which means that the powder cavity is smaller. That feature illustrates that the powder load can be controlled by controlling the thickness of the casing wall. The other difference is that in the case of casing 108, the forward and rearward sections of the casing are joined by a sleeve 110 which is formed integrally with the forward section of the case at its rearward surface. That sleeve fits into a circumferential groove in the forward face of the rearward section 112 of case 108. In the case of both embodiments, the sections of the case are welded together using a solvent material or ultra-sonics.

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The manner of interconnection can be understood more clearly by reference to Figure 10 where the reference numerals correspond to the numerals in Figure 9.

The same materials that are preferred for making shell cases are also suitable for encasing and serving as part of the bullet itself. Figure 8 illustrates a preferred form in which that can be done. Here, the lead pellet 114 has its rearward portion encased in a plastic cup 116. The sides and the bottom of the cup are integral, and at its forward rim it has an inwardly directed, segmented flange 118 which extends over the tapered forward part of the pellet 114 to ensure that the pellet is retained within the cup. In this case, the exterior surface of the cup is scored, much as it would be if knurled. The interaction between that scored surface and the forward end of casing 66 in Figure 7 is enough to ensure that the bullet will remain in place in such a shell. Bullets of the kind shown in Figure 8 are substantially less costly than conventional, all lead bullets, and for that reason may be preferred by recreational users and in practice ammunition.

In Figure 11 a rim fire cartridge is shown. The shell 120 is made of plastic, the primer powder 122 is disposed at the bottom of the powder cavity in an annular groove formed in the rim. The body 124 of powder occupies the remainder of the powder cavity. The bullet has a lead core 126 and an outer plastic covering 128.

One plastic, typical of those suitable for use in the invention, has the following physical qualities:

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	Density	1.24 Mg/meter cubed
	Water absorption	0.3% in 24 hours
5	Tensile strength	70.3 MPa at yield
	Tensile modulus	2482 MPa
	Tensile elongation	50-100% at break
	Flexural modulus	2689 MPa
	Flexural strength	15,400
10	Izod impact	69 J/m (at 22°C, 3.2mm specimen)
	Tensile impact	421 KJ/m ²
	Rockwell hardness	M69
	Heat deflection temperature	174°C
15	Flammability (ATB)	5 seconds
	Average extent of burning (AEB)	10mm
	Oxygen index rating	30
20	Thermal conductivity	0.26 W/m-°C.

Although I have shown and described certain specific embodiments of my invention, I am fully aware that many modifications thereof are possible. My invention, therefore, is not to be restricted except insofar as is necessitated by the prior art.

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The Claims

5 I Claim:

1. A bullet case formed of a high strength, flexible polymeric material.

10

2. The invention defined in Claim 1 in which said material is capable of undergoing elongation up to eighty percent without breaking.

15

3. The invention defined in Claim 1 in which said material comprises at least one of a polysulfone, a polyethelene sulfone or a polyimide-amide.

20

4. The invention defined in Claim 1 in which said bullet case forms a generally cylindrical tube and has a dividing wall extending transversely across its interior to form a primer cavity at the rearward end and a powder and bullet cavity at the forward end; and
bullet retaining means in the form of conformations molded integrally with said case at the inner surface of said powder and bullet cavity for retaining a bullet in situ within the forward end of said powder and bullet cavity.

30

5. The invention defined in Claim 4 in which said bullet retaining means includes an annular inwardly extending ring.

35

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6. The invention defined in Claim 5 in which
said annular ring comprises a flange extending inwardly
5 at the forward rim of said bullet case.

7. The invention defined in Claim 4 in which
said bullet retaining means includes a plurality of con-
10 formations projecting inwardly from the inner wall of
said powder and bullet chamber.

8. The invention defined in Claim 4 which
15 further comprises bullet insertion limiting means in
the form of conformations formed integrally with the
inner wall of said bullet case and within said powder
and bullet chamber for limiting the degree of insertion
of a bullet into said powder and bullet chamber.

20

9. The invention defined in Claim 8 in which
said insertion limiting means comprises at least one rib
formed on the inner wall of said powder and bullet cham-
25 ber.

10. The invention defined in Claim 4 which
further comprises a bullet disposed in, and having a
30 portion extending from, the forward end of said powder
and bullet cavity.

11. The invention defined in Claim 10 in which
35 said bullet has at least its outer cylindrical portion
and its integrally formed rearward portion made of a
high strength, flame resistant polymeric material.

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12. The invention defined in Claim 11 in which the interior part of said bullet is formed of metal.

5

13. The invention defined in Claim 4 which further comprises primer retaining means in the form of an annular inwardly projecting flange integrally formed at the rearward rim of said case.

10

14. The invention defined in Claim 4 in which said case has reduced outside diameter at its forward end.

15

15. The invention defined in Claim 4 in which said case is divided into sections along its length in the region of its powder and bullet cavity, the forward portion of the forwardmost section having reduced diameter; and

20

said sections being bonded together to form a continuous tubular structure.

25

16. The invention defined in either of Claims 4 and 15 in which said bullet case is formed of a material capable of undergoing elongation up to eighty percent.

30

17. The invention defined in either of Claims 4 and 15 in which said material includes at least one of a polysulfone, a polyethylene sulfone, or a polyimide-amide.

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18. A gun cartridge having a powder filled case formed of polymeric material.

5

19. The invention defined in Claim 18 in which said polymeric material has high strength and is flexible.

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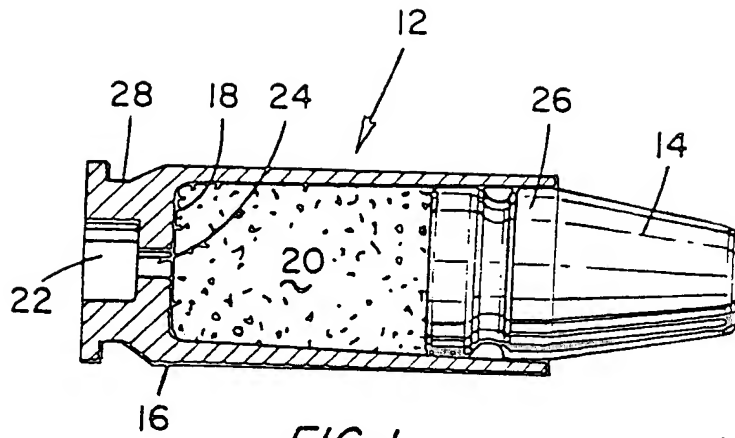


FIG. 1

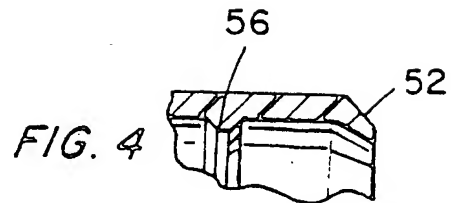


FIG. 4

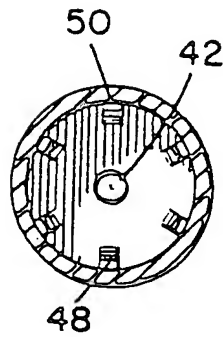


FIG. 3

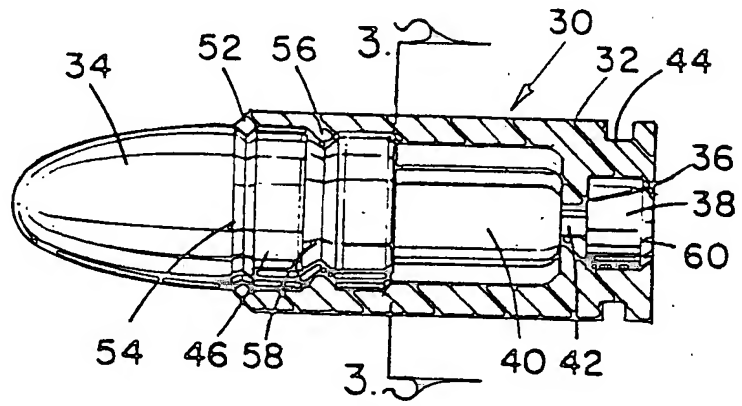


FIG. 2

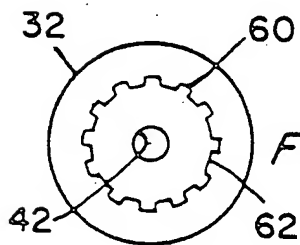
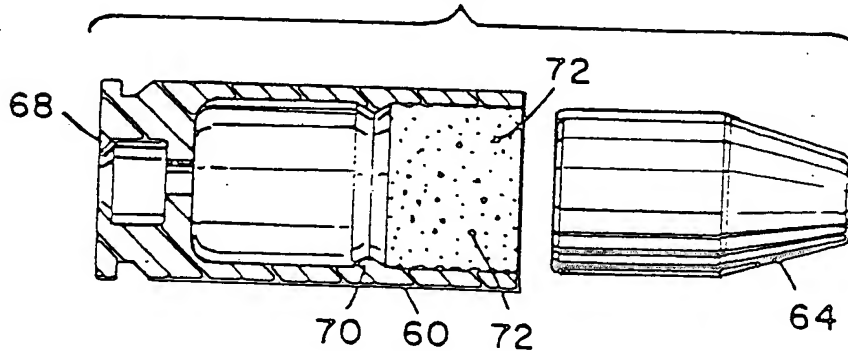


FIG. 6

FIG. 7



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